Investigating the Safety-Relevance of Limited Distinctive Features on a Multi Remote Tower-Working Position

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Remote Tower

✓ Single Remote Tower is operating
  – Airport Örnsköldsvik
  – Airport Sundsvall (from tomorrow on!)
✓ Operational experience available for Single Remote Tower
  – Operational benefits
  – Social working environment
✓ All problems seem solvable (technique/ human/ procedures)
✓ A challenge is still to approve the system
Multi Remote Tower

- Controlling at least two airports by one tower controller at a time
  - Independent
  - Low traffic volume
- The next step for increasing the effectiveness of Remote Tower
- Experience available from experimental and field studies in the scope of SESAR 6.9.3
- Increasing
  - cost-effectiveness of low density airports
  - work load
Visual Presentation

Horizontal Layout

Vertical Layout

Triangle Layout

Airport A  Airport B

Airport A  Airport B

Airport B  Airport C

SESAR 6.9.3 D32
Coping with Human Implications

✓ Three functions that are introduced by a Multi Remote Tower
  – Switching (attentional refocusing)
  – Merging/Opening an airport
  – Splitting up an airport (i.e. hand-over to another Remote Tower module)

✓ New hazards may result when functions are used inappropriate in a situation

✓ SESAR 6.9.3 (HP Assessment report D28) identified
  – Supervisory errors and
  – Confusion errors
  – Etc
Lesson Learned from Flight Deck-Safety

✓ Safety-relevant effects of complexity resulting from the functionality and assistance of automation
✓ Example Accident of TransAsia Airways flight GE235 from Taipei to Kinmen Island in 2015
  – shut down the wrong engine
  – the “misinterpretation of the pattern of data (cues) available” might have been caused by “similarity of cue patterns between malfunctions with very different sources”
Sources of Confusion

✓ Misattribution of the human memory causes confusion about the origins of retrieved information (Schacter & Wiseman, 2006)

✓ Similarity of information cues such as
  – taxiways designators,
  – aerodrome weather information (QNH, wind direction, strength),
  – reporting points,
  – operational agreements and
  – navigational aid and orientation (mountains, lakes, sea)

✓ Distinctive features are needed that support the human to encode and to associate the cues to the respective airport
Experimental Study

✓ Investigating the effects of limited distinctive features
✓ First conceptual study shall identify the relevance of forgetting and confusion
✓ Common cause in “lapses in memory”
✓ Slight knowledge available, which activities are most affected
✓ Open investigation
  – Identifying the affected activities of the ATCO
  – Identifying potential risk hot spots in the concept

Experimental-aided hazard identification
  – Gathering findings for further investigation (hypothesis development)
Experimental Setup

✓ Cooperation with TU Berlin and TU Darmstadt
✓ 5 ATCOs from the DFS
✓ 1 Hour and 20 minutes per trial with 3 pseudo-pilots (PPL licensed)
✓ 3 airports at a time
  – Dresden,
  – Dortmund and
  – Münster-Osnabrück
✓ 3 VFR movements (Cessna C172SP Skyhawk)
✓ Using one microphone (joined tower freq.)
✓ Traffic pattern included taxiing, take-off, crossing the control zone and landing.

Radar
Dortmund

Radar
Dresden

Radar
Münster-Osnabrück

Ground Surveillance

Visual Presentation
(3 Monitors)

Planning tool
Stress Testing Procedure

✓ Hazard induction for increasing uncertainty in operations
✓ ATCOs are instructed to recognize hazards and to report them instantly
✓ Induced uncertainty shall force the ATCOs to deviate from routine operations (increasing stress)
✓ Increasing awareness of the ATCOs for conceptual weaknesses
✓ Stimulating confusion and forgetting
## Stress Testing Procedure

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Animal accident</td>
</tr>
<tr>
<td>2.</td>
<td>Unauthorized entry of runway by ground vehicle</td>
</tr>
<tr>
<td>3.</td>
<td>Sever weather</td>
</tr>
<tr>
<td>4.</td>
<td>Unauthorized entry of control zone by aircraft (intruder)</td>
</tr>
</tbody>
</table>

Source: Meyer, Vogel & Fricke, 2010
Data Analysis

✓ Objective Data
  – Video and audio recordings from a video camera
  – Audio from voice communication
  – Key-stroke logs, logging switch events
  – Hazard detection

✓ Ex-post interviews
  – Closed-end questions for
    • reasoning the failed detection of hazards
    • information cues
  – Open interview for revealing weak points in the concept
Hazard Detection

✓ 14 hazard events were detected out of 20
✓ Hazards not detected
  – 4 of 5 not detected “Unauthorized entry of control zone by aircraft”
  – One of 5 “Unauthorized entry of runway by ground vehicle
  – One of 5 “sever weather”
✓ 3 of 14 hazard events could not be associated to the respective airport of hazard occurrence
✓ ATCOs argued that the design of the experimental setup influenced the probability of detecting the hazards
Detecting Confusion

- Identifying non-nominal behaviour (plausibility checks)
  - actual operational demands mismatches the selected airport
  - misunderstanding and mismatch in the expected advises and clearances
- Confusion of
  - one waypoint designator and
  - one airport selection
- Confirmation of the confusion by the respective ATCO during the open interview
- Difficulties of detecting confusion that is immediately recovered by the ATCO
Open Ex-Post Interviews

✓ Statements concerning the hazard “Unauthorized entry of control zone by aircraft”
  – “the borders of the control zones are poorly monitored”
  – “I completely hid them from my perceptual area”

✓ Poor sharing of attention between the airports

✓ ATCOs stated that confusion is probable for
  – ATIS- Information (QNH, wind direction and speed, aerodrome circuit)
  – designators of taxiways to and from the runway
Conclusion

✓ Confusion hazards could be observed and can be regarded as concept-related
  – Designators are too similar (ICAO conformity)
  – Poor management of attention
✓ ATCOs stated that safety-relevant operational information might mix up
  – False altimeter setting -> Accident Risk (ref. NTSB SEA03FA028)
✓ Forgetting could not be concluded
✓ Poor management of attention
  – Visual scanning pattern
  – Switching and refocusing the attention between the airports
Adjusting Attention and Distinctiveness

✓ Need for management of
  – information perception
  – attentional resources of the ATCO

✓ Means of management
  – avoiding the fragmentation of working pattern – planning traffic flow allows for establishing a harmonised order of actions and for setting the focus on one airport
  – adding additional features for distinguishing information (colour coding, font types, distance information)
  – adding a relaxation time after switching the airport
Further of Investigation

✓ Risk Analysis

– Design-related question: is the potential for confusion relevant for us?
– Does the hazard have a relevant impact on operations?
– Eye-Tracking for identifying indicators of confusion
– Situational Awareness testing allows for comparing the potential for confusion concerning single information cues
Thank you

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